Analysis and Integration of Acoustic, Optical and Traditional Data from the 1995 Arabian Sea Expedition

Peter B. Ortner
Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Causeway
Miami, FL 33149
Phone: 305-361-4384 Fax: 305-361-4392 Email: ortner@aoml.noaa.gov
Award# N000149710156
http://www.aoml.noaa.gov/ocd

LONG TERM GOALS

Our research has been directed at understanding the coupled biological and physical mechanisms controlling the fine-scale (1-10 m) vertical distributions of zooplankton, the ecological significance of these distributions and their effect upon other "particles" within the upper water column.

OBJECTIVES

Among the strongest atmospheric forcing of the upper water column observable anywhere in the world ocean, recurs in the Arabian Sea. Seasonally reversing monsoonal winds drive strong currents, produce complex eddy fields, deepen the mixed layer and induce both coastal and open ocean upwelling. In much of the region a shallow oxygen minimum is found year round beneath the mixed layer. These physical features directly affect primary production processes but may also be expected to influence the abundance, distribution and diversity of the animals dependent upon that production. During the 1995 field season the NOAA Ship Malcolm Baldrige made two cruises (an intermonsoonal cruise in April/May and a late monsoon cruise in August) during which we collected direct (MOCNESS) and indirect (acoustic and optical) data specifically addressing the following questions:

1) How do zooplankton size class spectra, vertical distribution and biomass respond to seasonal mixing and consequent changes in food availability?

2) Do both coastal and oceanic zooplankton populations respond similarly?

3) Do the abundance and vertical distribution of mesopelagic organisms respond to seasonal mixing and consequent changes in food availability?

4) What are the relative biomasses of zooplankton and mesopelagic populations?

5) How are the vertical distributions and diel migration patterns of zooplankton and mesopelagic populations modulated by the oxygen minimum?

APPROACH

The underlying rationale of our technical approach has been the conviction that to link physical and biological information into a dynamical understanding requires collecting data on fully comparable time and space

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1998		**00-00-1998 to 00-00-1998**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Analysis and Integration of Acoustic, Optical and Traditional Data from the 1995 Arabian Sea Expedition	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Miami,Rosenstiel School of Marine and Atmospheric Science,4600 Rickenbacker Causeway,Miami,FL,33149**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002252.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**4**	

scales. This assumption derives from the general observation that, while scales of biological and physical variation are often coupled, they are so in a complex and highly non-linear manner. Our field sampling is intended to provide information pre-requisite to dynamical understanding.

WORK COMPLETED

Immediately after the ship's return to the U.S. the acoustic subsystems (hull and tow vehicle) were calibrated and preliminary analyses made on subsets of the data to confirm the systems were operating and the quality of the data (collaboration with V. Holliday et al.). Those hull transducer data have now been entirely processed. Similarly all ADCP data from the Baldridge have been processed and analyzed (collaboration with C. Flagg et al.) both in regard to current structure and, using synoptic MOCNESS displacement volume measurements, in regard to zooplankton biomss. All zooplankton samples have now been enumerated for major taxa and second generation software has been developed to efficiently process optical particle count and multi-frequency data. Enumerations were performed at no cost to this project by our Ukranian collaborators using NOAA funds after the death of the project supported taxonomist last winter. Last in collaboration with G. Hitchcock cruise reports were completed and distributed including all CTD data, water bottle analyses and corrected sample logs.

RESULTS

Data analysis to date has documented a much larger difference between monsoonal and intermonsoonal plankton abundance than apparent during the data obtained by the Thompson. The reasons for this are being investigated but likely relate to the precise timing of the cruises. Careful analysis and intercomparison of 12KHz and ADCP data in light of synoptic MOC01 and MOC10 tows have permitted us to distinguish mesopelagic from zooplankton populations in the acoustic data. The result is not only improved understanding of their vertical migration patterns and the factors controlling these patterns but also sufficient context so that the extensive ADCP data collected by the Thompson and the other vessels participating can now be analyzed specifically and uniquely in regard to interseasonal and cross-regional differences in zooplankton abundance without confounding the results obtained by the presence of other more dominant scatterers.

IMPACTS

The data obtained are proving an essential addition to the overall Arabian Sea program given the emphasis of the Baldrige cruises upon animal populations including the larger mesopelagic forms not sampled by any other participating vessel. The cruises not only make overall temporal coverage more complete but in addition markedly increase spatial coverage by including the coastal areas of the lower Arabian penninsula and Somalia. These data are contributing to a manuscript for the second Arabian Sea DSR special volume in collaboration with G. Hitchcock. Moreover as described above the detailed analysis of our hull transducer data (12KHz and 150KHz ADCP) have defined the analytical context in which all other Arabian Sea ADCP biological data must be interpreted. These data are being used in conjunction with the analysis presented at ICES in September in another manuscript being prepared with the ICES authors for the same DSR special volume.

TRANSITIONS

The hardware and software developed provide and efficient mechanism for studying mesoscale and submesoscale processes in plankton communities and we are assessing the suitability of various sites to continue these investigations. The most promising appears to be seaward of the Florida Keys where exploratory sampling has revealed the regular generation of submesoscale baroclinically unstable eddies that markedly redistribute resident plankton communites. We have already begun the process of re-engineering the technology developed for the Arabian Sea program for deployment on shallow (<200m) moorings and have conducted successful tests of these systems.

RELATED PROJECTS

The Thompson and Baldrige data sets partially overlap but in general provide complementary spatial and temporal coverage. The various methods and instruments used aboard the Baldrige are intended to complement each other in providing a more complete assessment of the animal communties. In order to address the research questions posed we are collaboarating with Thompson and Baldridge investigators as enumerated below:

1) Zooplankton biomass assessment by backscatter difference, low frequency hull transducer and ADCP backscatter versus multifrequency and MOC-1 sample biomass and size distribution. Net tow and multifrequency data are needed given the inherent potential sources of error in single-frequency acoustic biomass assessment (with V. Holliday and S. Smith);

2) Mesopelagic biomass and size frequency assessment from the MOC-10 and the low frequency hull transducers. Although 62 MOC10 tows were obtained the continuous acoustic data are needed to extend spatial and temporal coverage in particular determining if extensive schools of mesopelagic organisms were missed by the discrete net tows (with V. Holliday and L. Madin);

3) Multifrequency and Optical Particle Count epizooplankton size frequency distribution versus in situ video assessment of taxonomic composition and size frequency and MOCNESS and vertical net tow samples. These “technical” comparisons are needed to properly interpret shuttle data prior to addressing the following question;

4) Integrated optical/acoustic data across littoral upwelling jets versus continous pump sampling, drifter data and continous hull-mounted acoustic data (with M. Baars, G. Hitchcock and V. Holliday).

5) Taxonomic composition of MOCNESS samples at the Omani Basin, along the Omani and Somali coasts and near the mooring site. These data will be pooled with Thompson MOCNESS data and markedly extend their spatial and temporal coverage (with M. Roman, K. Wishner and S. Smith);

6) Multifrequency acoustic data from the MOCNESS mounted unit versus similar data with MOCNESS and SEASOR mounted units from the Thompson (with S. Smith and V. Holliday);

PUBLICATIONS

Checkley, D.M., P.B. Ortner, F.E. Werner, L.R. Settle and S.R. Cummings. Spawning habitat of the Atlantic Menhaden in Onslow Bay, North Carolina. Accepted Fisheries Oceanography special volume.

Ortner, P.B., L. Crowder and D. Hoss. The South Atlantic Bight Recruitment Experiment: A Retrospective. Under Review Fisheries Oceanography special volume.

Luo, J., P.B. Ortner, D. Forcucci and S.R. Cummings (1998). Diel vertical migration of zooplankton and mesopelagic fish in the Arabian Sea. Invited contriution ICES, CM 1998/S:7.

Wanninkhof, R., G. Hitchcock, B. Wiseman, G. Vargo, P. Ortner et al. (1997) Gas exchange, dispersion and biological productivity on the West Florida Shelf: Results from a lagrangian tracer study. Geophysical Research Letters 24:1767-1770.

Checkley, D. M. , P.B. Ortner, L. Settle and S.R. Cummings (1997).A continuous underway fish egg sampler (CUFES. Fish. Oceangr. 6(2):58-73.